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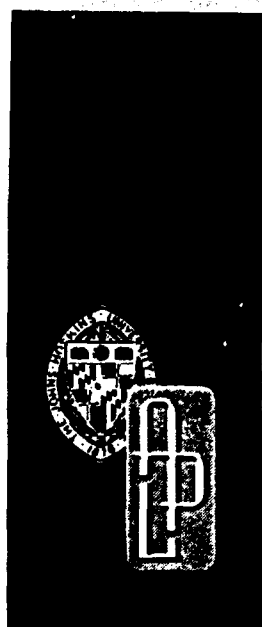
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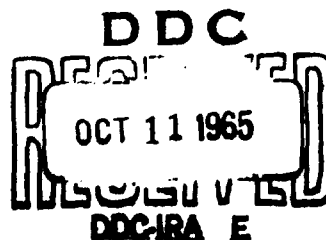


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Technical Memorandum

SUMMARY OF ACTIVITIES BUMBLEBEE TECHNICAL PANELS 1945 - 1964

Prepared by C. J. SMITH

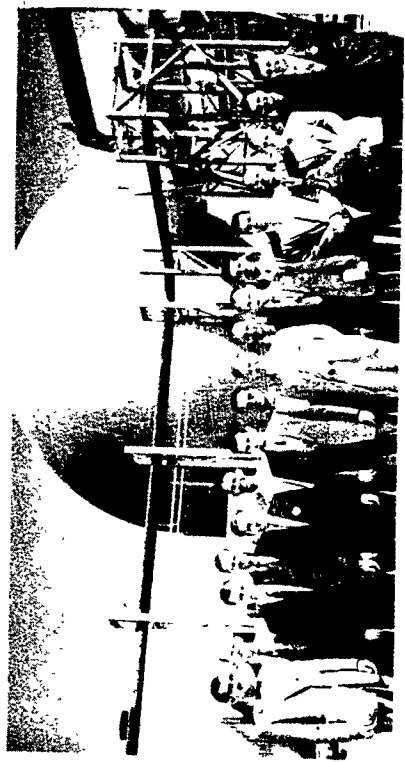




AERODYNAMICS PANEL
University of Texas/DRL



GUIDANCE PANEL
USS Norton Sound (AVM-1)



AERODYNAMICS PANEL
Arnold Eng. Devel. Ctr., Tullahoma, Tenn.



GUIDANCE PANEL
APL/JHU

BUMBLEBEE PANELS

TG-692
MAY 1965

Technical Memorandum

**SUMMARY OF ACTIVITIES
BUMBLEBEE TECHNICAL PANELS
1945 - 1964**

Prepared by C. J. SMITH

THE JOHNS HOPKINS UNIVERSITY • APPLIED PHYSICS LABORATORY
8621 Georgia Avenue, Silver Spring, Maryland 20910

Operating under Contract NOw 62-0604-c, Bureau of Naval Weapons, Department of the Navy

FOREWORD

The Bumblebee Technical Panels were conceived and instituted in 1945 as an integral part of the Bumblebee weapon development program. For twenty years these Panels, organized and managed by APL, served a number of useful functions in promoting guided missile technology and in providing a forum for working-level exchange of technical information by military, contractor, and APL personnel.

It is the intent of this Summary: (a) to document the objectives and history of the Panel concept as used in the Bumblebee program, (b) to list for easy reference the statistics on each Panel for membership, meetings and minutes, (c) to list in the Bibliography selected reference documents on Panel policy and actions. The technical problems treated by the Panels can be found in the individual Minutes published by the APL Technical Reports Group. These volumes testify to the breadth of scope of the subject matter.

The success and contribution of the Panels to the Bumblebee program are a tribute to those persons whose foresight and knowledge of the scientific-military interface led to the Section T concept with its intimate cooperative partnership of contractor, military, and central laboratory. That a group of Panels could maintain their momentum, usefulness, and technical calibre for twenty years is a tribute to the APL Panel chairmen and secretaries. The continued enthusiastic participation of contractors both by attendance at meetings and by contributing technical papers is evidence of the esteem in which the Bumblebee Panels were held and recognition of their continued value.

The Johns Hopkins University
APPLIED PHYSICS LABORATORY
Silver Spring, Maryland

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I. HISTORICAL SUMMARY OF BUMBLEBEE TECHNICAL PANELS

The original purpose and objectives of the Bumblebee Panels are delineated in the report on the Bumblebee program for 1945-1947¹ as follows:

Method of Operation

"The Director of APL has appointed technical panels in the several technical fields pertinent to the Bumblebee work; it is their function to review periodically the technical programs and to formulate problem statements. The recommendations of these panels are reviewed by the task board and the technical supervisor for Bumblebee before being submitted to the Director for action. Each panel has representation from those associate contractors having a major interest in the pertinent technical field and from APL. In at least one case, the panel also includes representation from non-Bumblebee operations. Representatives of the Research and Development Division of the Bureau of Ordnance are present at panel meetings.

Task Boards and Panels

"In scientific efforts, as in most others, an authoritarian system may appear more efficient than it actually is. Leadership which attempts to prescribe all activities and all thinking tends greatly to inhibit conception and growth of

¹Bumblebee Series Report No. 72, December 1947.

the new ideas and "hunches" which are essential to progress. Although the contractors associated with Section T are presumed to take technical direction from the Director of the Applied Physics Laboratory, in actual fact they receive a broad technical leadership of a liberal democratic type. To implement this philosophy, the Director of the Laboratory employs the mechanism of technical panels and task boards.

"To assist the boards in their evaluation of special fields in those tasks where such fields are large and perhaps technically complicated, panels have been set up. Composition of each panel includes representatives from all associate contractors engaged in its particular field of interest. In the Bumblebee task there are panels on propulsion, composite design, aerodynamics, guidance, launching, and warheads and fuzes. The obligation of each panel is to coordinate the efforts of the scientific talent and facilities in its field. It is a basic belief of APL that coordination in scientific programs can only be achieved when working level scientists are brought together.

"The technical panels are responsible for submitting statements of needs associated with the carrying out of the various technical programs required by the task. The task board, in turn, evaluates these statements and finally indicates the funds available to each of the several panels. Thereafter each panel recommends the distribution of moneys and effort within its field.

"Each panel carries out its recommendations through the formulation of problem statements. In this regard it should be emphasized that whereas the chairman of a panel, representing the task board and APL, has a great responsibility for generating technical problems which cover the field, he has

an even greater responsibility to achieve willing and active acceptance of such assignments by qualified contractors. Because of this relationship, the representative of each contractor must be empowered to accept or reject such assignments for his "team." In order to obtain the many benefits of pattern-wide participation, contractors are represented on each panel. Since these representatives are working-level scientists, each panel and each member on it has the right and, in fact, is expected to propose studies which would be of value. All such proposals are made in the form of problem statements.

"After approval by the cognizant panel, recommendations for new problems are passed through the associate Contracts office, scrutinized for budget and other considerations, and are finally presented for policy coordination to the task board, and then to the Director for approval.

"Thus the Director of the Laboratory receives recommendations which, while subjected to scrutiny by several groups, represent the ideas and desires of the working technical staffs of his own laboratory and of the associate contractors. This cooperative effort by the various members of the Bumblebee "team" is believed to be one of the strongest features of the Section T type of operation."

To achieve these objectives, three panels - Guidance, Launching, and Aerodynamics - were established in 1945-1946 and the first meetings held. In the spring of 1948, two additional panels - Composite Design and Propulsion - began operations. In addition, there were several informal meetings of a Warhead/Fuze group headed by C. F. Meyer and H. S. Morton but a formal Bumblebee Panel was not established.

The Launching Panel held thirteen meetings through November 1950 at which time its activities were melded with

the Composite Design Panel. The other four panels have continued their operations to date.

In the early years of their operation, the Bumblebee Panels pursued the general objectives outlined above and played an active role in formulating technical and policy recommendations. This function was particularly pertinent to the early development stage of the technologies involved with a real need for the intimate discussion of troublesome problems by all parties concerned in order to take the necessary corrective action and to plan future activities. As the Bumblebee program progressed into more advanced development and engineering phases, the panels as a mechanism for recommending specific technical programs and policies were supplanted by more direct management and coordinating techniques such as the Terrier Coordination Committee. This change represented the transition in both technical effort and contractual mechanism from early development to the project-oriented stage of weapon development.

The objectives of the panels as revised to meet these changing conditions were stated in March 1951² as being twofold: (a) "to focus research and development in external aerodynamics and internal aerodynamics, and other fields pertaining to aerodynamics, on the technical objectives of the Bumblebee program, especially as they relate to stability and control and other flight characteristics of guided missiles, and including internal aerodynamics only up to the point in the propulsion system where combustion occurs; and (b) to utilize all the resources in men, knowledge, and facilities

²"General Policy for Bumblebee Technical Panels," CS-809, 9 January 1959 (abstracted from Avery-Gibson letter dated 5 March 1951).

available in the Bumblebee family to form a broad basis of technical judgment for this program."

On these guidelines the panels have operated into 1964 with little change in overall purpose, although individual panels have tailored their activities to emphasize particular problems. In the fall of 1958, the Director of APL reviewed panel operations in some depth and concluded³ that no major changes in operation were required. At this time it was noted that the panels should as a corollary function: (a) broaden the thinking of junior APL men by active panel participation and (b) foster APL-contractor relationships by personal contact at panel meetings.

In recent years two factors have emerged which have significantly affected the modus operandi and the potential usefulness of Bumblebee panel activities as presently constituted.

1. Professional societies have increased in both number and breadth of interest to the point where, to some extent, their meetings provide an adequate "forum" for the exchange of advanced technical information in many fields. It should be noted, however, that such meetings often do not afford the freedom of informal discussion which has been a distinguishing feature of the Bumblebee panels. Too, individual companies are considerably more cautious in publicizing advanced developments to all of industry than in discussing such developments at panel meetings.

³"Discussion of Bumblebee Technical Panels," CS-735, 26 September 1958.

2. The current climate of DOD policy, with an emphasis on competitive procurement, PDP, and other such control mechanisms, has led to a more rigid interpretation of "conflict of interest" and security regulations regarding technical meetings. In addition, the responsibility for review of panel policy within the Bureau of Naval Weapons has been assumed by the Surface Missile Systems Technical Director (Code G-20)⁴ whereas prior to 1962 a rather loose monitoring had been carried out by the Missile Development Division (Code RM-11). Code G-20 has instituted a detailed control system extending not only to security matters but also to agenda subjects and participating organizations.

As a result of the above factors, the Laboratory has replaced the periodic panel meetings with symposia on subjects of specific and particular technical interest. It is intended that such symposia will treat areas not otherwise covered by the meetings of professional societies or similar organizations.

⁴"Bumblebee Panel and Committee Meetings," ltr. Chief, BuWeps, G-20:RKI to Director, APL, 15 July 1964.

II. PANEL COMPOSITION

Bumblebee Aerodynamics Panel

The Bumblebee Aerodynamics Panel (BBAP) was established as a panel of expert consultants to review and make recommendations for the aerodynamic programs for the Bumblebee program. It functioned as an advisor to APL in planning and conducting the missile developmental programs and as a broad base for making technical decisions. It served as a forum for the interchange of information on varied aerodynamic ideas and accomplishments.

The Panel operated in close concert with the Scheduling Committee of OAL Wind Tunnel during its period of operation, and assisted the Committee by reviewing the technical merit of wind tunnel test requests.

The Panel functioned as an advisor to APL in the early planning of the Handbook of Supersonic Aerodynamics and in the preparation of some portions of the Handbook.

There was a clearly defined delineation of objectives and areas of interest between the BBAP and Bureau of Naval Weapons Advisory Committee on Aeroballistics (BOWACA) and its predecessor, Bureau of Ordnance Committee for Aeroballistics (BOCA). BOWACA was, and is, concerned primarily with basic aeroballistic research; whereas the BBAP was interested mainly in Bumblebee missile development programs and a limited amount of supporting research leading directly toward solutions of missile program problems. The activities of the two groups were well known to one another at all times because of

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the close working relationship between BuWeps and APL. In addition, certain individuals at times were simultaneously members of the BBAP and BOWACA (or BOCA). These factors prevented any duplication of effort by the two groups.

Table I
Bumblebee Aerodynamics Panel Chronology

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
<u>Chairmen</u>																		
R. P. Petersen																		
C. N. Warfield																		
A. R. Eaton																		
E. A. Bonney																		
L. L. Cronvich																		
<u>Secretaries</u>																		
G. M. Robertson																		
H. H. Howell																		
L. I. Barbier																		
P. E. Schwartz																		
C. S. Perry																		
<u>Member Organizations</u>																		
Bendix/Mishawaka																		
Cornell Aeronautical Lab.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Curtiss Wright	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
General Dynamics/San Diego/Pomona	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
McDonnell Aircraft Corp.																		
New Mexico School of Mines	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
North American Aviation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ordnance Aerophysics Lab.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Univ. of Michigan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Univ. of Texas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Univ. of Virginia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Univ. of Wisconsin	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table II
Bumblebee Aerodynamics Panel Meetings

MEETING		HOST AND LOCATION	MINUTES	
NO.	DATE		REPORT NO.	DATE
1	12/9/46	APL - Silver Spring, Maryland	Memo	Undated
2	3/13/47	Consolidated Vultee, Downey, Calif.	Memo	Undated
3	6/17/47	Consolidated Vultee, Daingerfield, Texas	Memo	Undated
4	10/3/47	Univ. of Michigan, Ann Arbor, Michigan	Memo	Undated
5	1/22-23/48	APL - Silver Spring, Maryland	TG-14-1	2/16/48
6	4/27-28/48	APL - Silver Spring, Maryland	TG-14-2	7/15/48
Special	6/4/48	APL - Silver Spring, Maryland	TG-14-3	9/20/48
7	8/2-3-4/48	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-14-4	11/15/48
8	12/1-2-3/48	Consolidated Vultee, San Diego, Calif.	TG-14-5	2/1/49
9	3/23-24-25/49	APL - Silver Spring, Maryland	TG-14-6	5/30/49
10	7/14-15/49	APL - Silver Spring, Maryland	TG-14-7	8/24/49
11	11/3-4/49	Univ. of Texas/DRL, Austin, Texas	TG-14-8	12/30/49
12	3/14-15/50	APL - Silver Spring, Maryland	TG-14-9	6/6/50
13	7/18-19/50	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-14-10	Undated
14	12/5-6/50	Consolidated Vultee, San Diego, Calif.	TG-14-11	2/1/51
15	4/3-4/51	APL - Silver Spring, Maryland	TG-14-12	5/28/51
16	8/1-~/'51	APL - Silver Spring, Maryland	TG-14-13	11/1/51
17	11/27-28/51	Consolidated Vultee, Daingerfield, Texas	TG-14-14	3/1/52
18	3/26-27/52	Univ. of Michigan, Ann Arbor, Michigan	TG-14-15	7/23/52
19	8/12-13/52	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-14-16	10/1/52
20	12/2-3-4/52	Consolidated Vultee, San Diego, Calif.	TG-14-17	3/16/53
21	4/7-8/53	APL - Silver Spring, Maryland	TG-14-18	7/11/53
22	8/11-12/53	McDonnell Aircraft Corp., St. Louis, Mo.	TG-14-19	9/30/53
23	12/3-4/53	Bendix Corporation, Mishawaka, Indiana	TG-14-20	3/26/54
24	3/23-24/54	Univ. of Texas/DRL, Austin, Texas	TG-14-21	10/8/54
25	6/29-30/54	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-14-22	10/8/54
26	10/27-28/54	Convair, Pomona, Calif.	TG-14-23	3/1/55
27	2/16-17/55	APL - Howard County, Maryland	TG-14-24	May 1956
28	6/1/55	APL - Howard County, Maryland	TG-14-25	12/1/55
29	9/7-8/55	McDonnell Aircraft Corp., St. Louis, Mo.	TG-14-26	May 1956
30	1/4-5/56	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-14-27 TG-14-37A	May 1956
31	3/6-7/56	Bendix Corporation, Mishawaka, Indiana	TG-14-28	July 1956
32	6/6/56	APL - Howard County, Maryland	TG-14-29	Aug., 1956
33	9/12-13/56	Ordnance Aerophysics Lab., Daingerfield, Texas	TG-14-30	Jan. 1957
34	12/4-5/56	Univ. of Michigan, Ann Arbor, Michigan	TG-14-31 TG-14-31A	Mar. 1957
35	3/5-6/57	Convair, Pomona, California	TG-14-32	June 1957
36	6/4-5/57	APL - Howard County, Maryland	TG-14-33 TG-14-33A	Aug. 1957
37	8/27-28/57	Arnold Eng. Dev. Center, Tullahoma, Tenn.	TG-14-34	Nov., 1957
38	3/21/58	Ames Aero. Lab., Moffett Field, Calif.	TG-14-35	Undated
39	9/30,10/1-2/58	Univ. of Texas/DRL, Austin, Texas	TG-14-36 TG-14-36A	Undated
40	5/12-13-14/59	APL - Howard County, Maryland	TG-14-37 Vols. I & II and TG-14-37A	Undated
41	9/29-30/59	McDonnell Aircraft Corp., St. Louis, Mo.	TG-14-38	Undated
42	5/10-11-12/60	Univ. of Michigan, Ann Arbor, Michigan	TG-14-39 TG-14-39A	Undated
43	9/27-28/60	Bendix Corporation, Mishawaka, Indiana	TG-14-40	Undated
44	5/9/61	APL - Howard County, Maryland	TG-14-41	Aug. 1961
45*	11/15-16/61	APL - Howard County, Maryland	TG-420-1	Jan. 1962
46	5/8-9/62	General Dynamics/Pomona, Calif.	TG-14-42	Aug. 1962
47*	3/19-20/63	APL - Howard County, Maryland	TG-420-2	May 1963
48	9/10-11/63	Univ. of Texas/DRL, Austin, Texas	TG-14-43	Nov. 1963

*Joint Panel Meeting

Composite Design Research Panel

At its organizational meeting on September 10, 1948, the Panel established as its objective the critical examination of new designs for missiles in order to influence the thinking and planning of the various APL and contractor groups working on specific phases of missile design. Specifically, this group was to consider overall design characteristics of missiles as they were developed as well as to review fields of technical endeavor which would result in better overall missile design. The immediate design objectives of the Panel were to make STV-3's usable shipboard weapons and to develop modifications to the XPM which would permit its shipboard utilization as a missile. The long term objective was to consider the design of missiles determined to be of value in the Laboratory's program of service to the Navy.

During the first several years of the Panels existence, agenda items were primarily associated with specific missile development and design problems, especially the interfaces and integration of various subsystems. By 1952 the problems of missile testing were explored and shortly thereafter Terrier reliability was a major topic of discussion.

The Panel's interests broadened in the middle 1950's, and discussions of weapons systems, both Navy and non-Navy, were included. When Terrier and Talos missiles were introduced into the Fleet, shipboard installation, handling, launch, and weapon direction problems were examined.

From 1958 on, the Panel's agenda included an increasing number of subjects associated with high-temperature materials for engine exhaust hardware and for hypersonic re-entry. Problems associated with Polaris weapons were also discussed.

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With the introduction of APL into near-earth satellite development, the Panel again showed a change of emphasis and many subjects involved in space technology appeared in the later meetings. Included were talks on the Navy Navigation Satellite, geodetic satellites, manned space capsules, launch vehicles, and satellite subsystems such as solar and nuclear power supplies.

In the expansion of the Panel's fields of interest, the original objectives were not compromised, however, and missile development programs and their associated problems were regularly reviewed through status reports and the presentation and discussion of special topics.

Table III
Bumblebee Composite Design Panel Chronology

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
<u>Chairmen</u>																			
J. F. R. Floyd																			
A. J. Bell																			
<u>Secretaries</u>																			
R. E. Wheeler																			
P. E. Schwartz																			
<u>Member Organizations</u>																			
Aerojet-General								X	X	X	X	X	X	X	X	X	X	X	X
Allegany Ballistics Lab.				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bendix/Minshaw							X	X	X	X	X	X	X	X	X	X	X	X	X
Cornell Aeronautical Lab.				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Convair/San Diego (CVAC/SD)				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Convair/Pomona (CVAC/PO)								X	X	X	X	X	X	X	X	X	X	X	X
Lockheed/Sunnyvale																			
McDonnell Aircraft Corp.								X	X	X	X	X	X	X	X	X	X	X	X
North American Aviation				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
University of Texas/DRL				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table IV
Bumblebee Composite Design Panel Meetings

MEETING		HOST AND LOCATION	MINUTES	
NO.	DATE		REPORT NO.	DATE
Planning	3/22/48	APL - Silver Spring, Maryland	TG-60-1	4/8/48
1	1/11/49	APL - Silver Spring, Maryland	TG-60-2	2/10/49
2	5/19/49	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-60-3	6/20/49
3	10/20/49	APL - Silver Spring, Maryland	TG-60-4	11/22/49
4	3/6-7/50	North American Aviation, Downey, Calif.	TG-60-5	4/20/50
5	7/20/50	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-60-6	10/31/50
6	12/14/50	APL - Silver Spring, Maryland	TG-60-7	2/26/51
7	4/12-13/51	Consolidated Vultee Aircraft, San Diego, Calif.	TG-60-8	6/1/51
8	Sept. 1951	APL - Silver Spring, Maryland	TG-60-9	12/10/51
9	2/5-6/52	Univ. of Texas/DRL, Austin, Texas	TG-60-10	4/15/52
10	6/24-25/52	Allegany Ballistics Lab., Cumberland, Maryland	TG-60-11	8/15/52
11	11/6-7/52	Bendix Corporation, South Bend, Indiana	TG-60-12	2/2/53
12	3/11-12/53	North American Aviation, Downey, Calif.	TG-60-13	5/1/53
13	8/5-6/53	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-60-14	9/4/53
14	12/16-17/53	APL - Silver Spring, Maryland	TG-60-15	2/15/54
15	4/28-29/54	Aerojet-General Corp., Azusa, Calif.	TG-60-16	7/10/54
16	9/21-22/54	Allegany Ballistics Lab., Cumberland, Maryland	TG-60-17	11/8/54
17	1/19-20/55	APL - Howard County, Maryland	TG-60-18	4/15/55
18	5/24-25/55	Convair/Pomona, Calif.	TG-60-19	6/15/55
19	10/19-20/55	McDonnell Aircraft Corp., St. Louis, Mo.	TG-60-20	12/1/55
20	2/8-9/56	APL - Howard County, Maryland	TG-60-21	May 1956
21	6/26-27/56	Bendix Corporation, Mishawaka, Indiana	TG-60-22	Jan. 1957
22	10/2-3/56	Thompson Products, Inc., Cleveland, Ohio	TG-60-23	June 1957
23	1/23-24/57	APL - Howard County, Maryland	TG-60-24	Sept. 1957
24	6/17-18/57	Aerojet-General Corp., Sacramento, Calif.	TG-60-25	Mar. 1958
25	11/12-13/57	Allegany Ballistics Lab., Cumberland, Maryland	TG-60-26	10/2/58
26	4/9-10/58	APL - Howard County, Maryland	TG-60-27	1/30/60
27	11/12-13/58	Convair/Pomona, Calif.	TG-60-28	Undated
28	5/6-7/59	APL - Howard County, Maryland	TG-60-29	Undated
29	11/12-13/59	North American Aviation, Downey, Calif.	TG-60-30	July 1961
30	4/20-21/60	McDonnell Aircraft Corp., St. Louis, Mo.	TG-60-31	10/31/60
31	11/16-17/60	APL - Howard County, Maryland	TG-60-32	Aug. 1961
32	4/26-27/61	Lockheed Aircraft Corp., Sunnyvale, Calif.	TG-60-33	Apr. 1963
33*	11/15-16/61	APL - Howard County, Maryland	TG-420-1	Jan. 1962
34	5/9-10/62	Martin-Marietta Corp., Orlando, Fla.	TG-60-34	Jan. 1963
35*	3/19-20/63	APL - Howard County, Maryland	TG-420-2	May 1963
36	11/20-21/63	McDonnell Aircraft Corp., St. Louis, Mo.	TG-60-35	Mar. 1964

*Joint Panel Meeting

Bumblebee Guidance Panel

The Bumblebee Guidance Panel first met informally in early 1946 and was officially chartered in August 1946 under the chairmanship of Dr. R. B. Roberts. The original member organizations included Bendix, CVAC, Cornell Aeronautical Laboratory, Farnsworth, RCA, Submarine Signal, and The University of Texas/DRL. The responsibility of the Panel was "to perform critical surveys on the Bumblebee Guidance Program underway and as proposed and to recommend alterations in such programs as is indicated for the improvement of the guidance phase of the Bumblebee prototype and related guidance vehicles."

The early years of the Panel were concentrated on planning the guidance program for Section T, including recommending division of work and funds among the associate contractors. Minutes of these meetings show a breadth and depth of discussion on a wide variety of both "bottleneck" and long-range problems.

In 1950, the major responsibilities of the Panel were defined as insuring "that the prototype (guidance) effort is adequately supported by a program of research and development" and that the results of the Panel's activities should be crystallized in specific recommendations to APL. This shift in emphasis from program policy matters to more strictly technical problems followed naturally the progress of guidance hardware from its conceptual beginnings into prototype flight tests and finally to commitment to a Terrier production missile. Furthermore, as guided missile technology advanced, the Panel devoted an increasing part of its effort to staying abreast of new concepts and techniques which might be applicable to the Bumblebee program. New member organizations

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were added and outside speakers were invited to present significant new ideas to the Panel.

As an example of the range of Panel interests by 1964, a typical agenda included five papers on current Bumblebee weapon systems, a group of five papers covering the sea clutter problem in depth, a presentation on the MOSAR system, a paper on a specific microelectronics application, and two papers on components.

Panel meetings have been held at contractors' plants and also at the various test ranges in order to provide the members with a first hand look at the weapon hardware either under development or being produced in the Bumblebee program. Visits were made to the Naval Ordnance Test Station, White Sands Missile Range, and the USS Norton Sound, where Navy representatives took the opportunity to comment pointedly on operational test problems.

Table V
Bumblebee Guidance Panel Chronology

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
<u>Chairmen</u>																			
R. B. Roberts																			
D. T. Sigley																			
G. Worsley																			
W. A. Good																			
R. W. Larson																			
A. G. Schulz																			
D. B. Staake																			
<u>Secretaries</u>																			
D. L. Gunter																			
E. R. Salzer																			
C. J. Smith																			
<u>Member Organizations</u>																			
ASCOOP					X														
Baird Associates						X		X	X	X	X	X	X	X	X	X	X	X	X
Bell Telephone Labs.																			
Bendix/Wishawaka	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bendix/PDOL	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cornell Aeronautical Lab.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
General Dynamics/SD (CVAC/RD)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
General Dynamics/Po (CVAC/Po)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Goodyear Aircraft	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITT Fed. Labs./Farnsworth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Kearfott Co.																			
McDonnell Aircraft Corp.																			
Naval Research Laboratory						X	X	X	X	X	X	X	X	X	X	X	X	X	X
New Mexico State Univ. (NMAAMA)						X	X	X	X	X	X	X	X	X	X	X	X	X	X
Radio Corp. of America	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sperry Gyroscope Co.																			
Submarine Signal		X																	
Texas Instruments, Inc.																			
University of Texas/DRL	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
University of Virginia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Varian Associates																			
Westinghouse/Baltimore																			

Table VI
Bumblebee Guidance Panel Meetings

MEETING		HOST AND LOCATION	MINUTES	
NO.	DATE		REPORT NO.	DATE
1	9/13/46	Consolidated Vultee, Vultee Field, Calif.	TG-9-1	9/13/46
	5/24/50	APL - Silver Spring, Maryland	TG-9-1	
9	5/21-22/47	Farnsworth Television & Radio Corp.	TG-9-2	6/23/47
10	7/17-18/47	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-9-3	8/23/47
11	9/18-19/47	Submarine Signal Co., Boston, Mass.	TG-9-4	9/24/47
12	13/8-9/47	CVAC/San Diego, Calif.	TG-9-5	12/24/47
13	2/19-20/48	APL - Silver Spring, Maryland	TG-9-6	3/4/48
14	4/15-16/48	Radio Corporation of America, Camden, N. J.	TG-9-7	5/15/48
15	6/17-18/48	Bendix Corporation, Teterboro, N. J.	TG-9-8	7/1/48
16	9/9-10/48	Bendix Corporation, South Bend, Indiana	TG-9-9	10/7/48
17	11/18-19/48	APL - Silver Spring, Maryland	TG-9-10	1/27/49
18	1/31/49	APL - Silver Spring, Maryland	TG-9-11	3/8/49
19	5/5-6/49	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-9-12	7/29/49
20	9/30-10/3/49	CVAC/San Diego, and Bendix/Hollywood, Calif.	TG-9-13	11/30/49
21	12/7-8/49	APL - Silver Spring, Maryland	TG-9-14	2/1/50
22	3/23-24/50	Univ. of Virginia, Charlottesville, Va.	TG-9-15	6/12/50
23	9/22/50	CVAC/San Diego, Calif.	TG-9-16	11/15/50
24	12/7-8/50	Bendix Corporation, South Bend, Indiana	TG-9-17	3/7/51
25	4/2-3/51	Capehart Farnsworth, Ft. Wayne, Indiana	TG-9-18	6/15/51
26	8/2-3/51	Radio Corporation of America, Camden, N. J.	TG-9-19	9/30/51
27	12/6-7/51	Applied Science Corp. of Princeton, N. J.	TG-9-20	2/5/52
28	4/9-10-11/52	Ft. Bliss, Texas and White Sands Proving Grounds, New Mexico	TG-9-21	6/2/52
29	7/7-8-9/52	Baird Associates, Inc., Cambridge, Mass.	TG-9-22	9/12/52
30	10/28-29/52	APL - Silver Spring, Maryland	TG-9-23	12/19/52
31	5/5-6-7-8/53	CVAC/Pomona, Calif.	TG-9-24	8/21/53
32	10/22-23/53	Bendix Corporation, Mishawaka, Indiana	TG-9-25	12/30/53
33	3/4-5/54	APL - Silver Spring, Maryland	TG-9-26	5/15/54
34	7/22-23/54	Sperry Gyroscope Co./Great Neck, L. I., N. Y.	TG-9-27	9/30/54
35	11/15-16/54	Goodyear Aircraft Corp., Akron, Ohio	TG-9-28	1/21/55
36	4/20-31/55	APL - Silver Spring, Maryland	TG-9-29	6/30/55
37	9/27-28/55	McDonnell Aircraft Corp., St. Louis, Mo.	TG-9-30	11/30/55
38	2/21-22-23/56	White Sands Proving Grounds, New Mexico	TG-9-31	4/30/56
39	6/12-13/56	APL - Silver Spring, Maryland	TG-9-32	8/30/56
40	11/15-16/56	Bendix Corporation, Mishawaka, Indiana	TG-9-33	2/15/57
41	2/27-28/57	Goodyear Aircraft Corp., Litchfield Pk., Ariz.	TG-9-34	5/20/57
42	6/19-20/57	Sperry Gyroscope Co., Great Neck, L. I., N. Y.	TG-9-35	11/1/57
43	10/23-24/57	APL - Howard County, Maryland	TG-9-36	12/19/57
44	2/25-27/58	USS Norton Sound, Pt. Hueneeme, and Convair/Pomona, Calif.	TG-9-37	May 1958
45	6/18-19/58	Bell Telephone Labs., Inc., Whippany, N. J.	TG-9-38	Sept. 1958
46	10/15-16/58	Varian Associates, Palo Alto, Calif.	TG-9-39	Dec. 1958
47	2/18-19/59	Univ. of Texas/DRL, Austin, Texas	TG-9-40	Apr. 1959
48	6/17-18/59	ITT Laboratories, Nutley, N. J.	TG-9-41	July 1959
49	10/11-15/59	APL - Howard County, Maryland	TG-9-42	Dec. 1959
50	2/17-18/60	Texas Instruments, Inc., Dallas, Texas	TG-9-43	June 1960
51	6/22-23/60	Fairchild Camera & Instrument Corp., Syosset, L. I., N. Y.	TG-9-44	Undated
52	10/19-20/60	Raytheon Mfg. Co., Wayland, Mass.	TG-9-45	Undated
53	2/15-16/61	New Mexico State Univ./PSL, Univ. Park, N. M.	TG-9-46	Apr. 1961
54	6/21-22/61	Bendix/Pacific Div., North Hollywood, Calif.	TG-9-47	Aug. 1961
55	10/18-19/61	APL - Howard County, Maryland	TG-9-48	Jan. 1962
56	4/18-19/62	McDonnell Aircraft Corp., St. Louis, Mo.	TG-9-49	June 1962
57	10/24-25/62	Westinghouse Electric Corp., Baltimore, Md.	TG-9-50	Jan. 1963
58	4/24-25/63	General Dynamics/Pomona, Calif.	TG-9-51	July 1963
59	4/22-23/64	APL - Howard County, Maryland	TG-9-52	June 1964

Bumblebee Launching Panel

The Bumblebee Launching Panel was formed on July 25, 1946 to coordinate the development of launching devices for the Bumblebee program and to focus attention on the longer range needs so that the R&D efforts of the participating laboratories could be directed in the most worthwhile channels. An important secondary objective was to provide a formal mechanism for continuing interchange of information on rocket and launcher development in related national programs that could be profitably applied to Bumblebee work.

Major accomplishments which were a direct result of the Launching Panel deliberations during its five year life included:

1. Establishment of the Rocket Propellant Manual, which led to formation of the Solid Propellant Information Agency, the Liquid Propellant Information Agency, and finally the Composite Propellant Information Agency.
2. Development at ABL and Aerojet of the first large solid propellant booster rockets. This established the basis for Terrier, Talos, and Nike booster rockets, which pioneered the later Polaris rocket development.
3. Established a program for jet vane stabilization of rockets which was proven feasible by flight tests.
4. Brought together in close working relationship, representatives of all programs in the U.S. concerned with launching and booster rocket development. This resulted in development and flight demonstration of booster rockets with efficiency that has not been matched in later work.

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5. Defined criteria for shipboard launching systems and provided first assessment of launcher design trade-offs.
6. Identified the need for data on the blast effects produced on shipboard by the rocket jet and established cooperative programs to provide the necessary data.

Table VII
Bumblebee Launching Panel Chronology

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
<u>Chairmen</u>																			
A. Kossinkoff																			
W. H. Avery																			
<u>Secretary</u>																			
B. A. Kvist																			
<u>Member Organizations</u>																			
Cornell Aeronautical Lab.	X	X	X	X	X														
Consolidated Vultee	X	X	X	X	X														
Aerojet Engineering Corp.	X	X	X	X	X														
Allegany Ballistics Lab.	X	X	X	X	X														
M. W. Kellogg		X	X	X	X														
Curtiss-Wright			X	X	X														
Mass. Inst. of Technology			X	X	X														

Table VIII
Bumblebee Launching Panel Meetings

MEETING			MINUTES	
NO.	DATE	HOST AND LOCATION	REPORT NO.	DATE
1	7/25/46	APL - Silver Spring, Maryland	TG-4-1	9/23/46
2	11/14-15/46	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-4-2	1/23/47
3	2/19-20/47	Aerojet Engineering, Pasadena, Calif.	TG-4-4	4/7/47
4	6/2-3-4/47	APL - Silver Spring, Maryland	TG-4-5	7/1/47
		"Summary of R&D on Launching for Task F"	TG-4-6	6/30/47
		"Required Characteristics for Shipboard Launching" - by Levering Smith, CDR., USN	TG-4-7	8/5/47
5	9/19/47	M. W. Kellogg Company, New York, N. Y.	TG-4-8	11/7/47
6	2/10-11/48	Allegany Ballistics Lab., Cumberland, Maryland	TG-4-9	5/3/48
7	6/28-29/48	Consolidated Vultee, San Diego, Calif.	TG-4-10	9/3/48
8	10/21-22/48	Curtiss Wright Corp., Woodbridge, N. J.	TG-4-11	12/3/48
9	2/24-25/49	APL - Silver Spring, Maryland	TG-4-12	5/16/49
			TG-4-12A	
10	7/7-8/49	M. W. Kellogg Company, Jersey City, N. J.	TG-4-13	9/30/49
			TG-4-13A	
11	11/30-12/1-2/49	Boeing Airplane Co., Seattle, Washington	TG-4-14	2/6/50
			TG-4-14A	
12	5/11-12/50	Cornell Aeronautical Lab., Buffalo, N. Y.	TG-4-15	7/1/50
13	11/2-3/50	Allegany Ballistics Lab., Cumberland, Maryland	TG-4-16	12/5/50
			TG-4-16A	

Bumblebee Propulsion Panel

The Bumblebee Propulsion Panel was formed in 1946 to bring together representatives from industry, universities, and applied science laboratories and thus provide understanding and data applicable to design and engineering of a ramjet propulsion system for a surface-to-air missile system. In carrying out this task, the Panel functioned as an advisor to the Director of APL/JHU by coordinating the work actually underway at the various organizations and thus guiding the future planning of the propulsion program.

The functions of the Panel were further broadened in 1951 to sponsor technical discussions of research and development in the overall propulsion field through interchange of information between outside organizations and those organizations working in the Bumblebee program. This latter effort has been especially successful in bringing together a wide variety of experts for detailed discussions of current progress in the field.

A development subcommittee, the Working Committee on Propulsion (WCOP), of the Panel was established to focus attention upon the problems involved with development of the actual combustion system hardware by applying the propulsion research studies. This committee was composed of representatives from APL and the industrial contractors. It was later redesignated the Talos Committee on Propulsion (TCOP), confining its efforts to one specific missile system.

The Panel also acted as an advisory group to the Director of APL/JHU relative to planning the scientific work being carried out in the engine test facility at the Ordnance Aerophysics Laboratory, Daingerfield, Texas, for the Bumblebee program as well as outside organizations. A subcommittee was

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formed to handle details and to act in urgent cases without the need to consult the entire Panel. This subcommittee later became the Executive Scheduling Committee which handled all scheduling activities.

The Propulsion Panel reviewed periodically work in the entire propulsion program and made recommendations regarding facility modifications and new facilities required by the Bumblebee contractors to carry out planned work.

Table IX
Bumblebee Propulsion Panel Chronology

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
<u>Chairmen</u>																			
W. H. Goss																			
W. H. Goss - J. E. Cook																			
J. E. Cook																			
W. H. Goss																			
W. H. Avery																			
<u>Secretaries</u>																			
R. K. Dahlstrom																			
H. F. Kirk																			
<u>Member Organizations</u>																			
Allison Div., Gen. Motors																		X	
Atlantic Research Corp.																	X	X	
Bendix	X	X	X	X	X		X			X							X	X	
Boeing											X						X	X	
Cal. Tech./JPL										X									
Cornell Aeronautical Lab.	X	X	X																
Curtiss Wright Corp.																			
J. A. Drake, Consultant																	X		
Esso Research & Eng.	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
General Dynamics/Convair	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
General Dynamics/OAL	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
General Electric/FPL																			
The Johns Hopkins Univ.									X	X	X	X	X	X	X	X	X	X	
Marquardt	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
Princeton Univ.									X	X	X	X	X	X	X	X	X	X	
Rocketdyne/NAA									X	X	X	X	X	X	X	X	X	X	
Texaco Experiment, Inc.	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
Univ. of Texas/DBL	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
Univ. of Virginia	X	X	X	X	X														
Univ. of Wisconsin	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	
Vanderbilt Univ.	X	X	X	X	X														
Westinghouse Res. Labs.	X	X	X	X	X														

Table X
Bumblebee Propulsion Panel Meetings

MEETING		HOST AND LOCATION	MINUTES	
NO.	DATE		REPORT NO.	DATE
1	4/20-30/48	APL - Silver Spring, Maryland	TG-63-1	10/26/49
2	8/5-6/48	APL - Silver Spring, Maryland	TG-63-2	9/17/48
3	11/11-12/48	APL - Silver Spring, Maryland	TG-63-3	1/6/49
4	5/2-3/49	APL - Silver Spring, Maryland	TG-63-4	5/31/49
5	7/28-29/49	APL - Silver Spring, Maryland	TG-63-5	8/26/49
6	10/27-28/49	APL - Silver Spring, Maryland	TG-63-6	10/27/49
7	2/9-10/50	APL - Silver Spring, Maryland	TG-63-9	3/30/50
8	6/1-2/50	Ordnance Aerophysics Lab., Daingerfield, Texas	TG-63-12	Undated
9	7/27-28/50	Consolidated Vultee, San Diego, Calif.	TG-63-13	10/24/50
10	4/24-25/51	APL - Silver Spring, Maryland	TG-63-18	7/5/51
11	11/1-2/51	APL - Silver Spring, Maryland	TG-63-20	1/7/52
12	4/17-18/52	APL - Silver Spring, Maryland	TG-63-23	8/27/52
13	10/27-28/52	Princeton University, Princeton, N. J.	TG-63-25	2/16/53
14	5/7-8/53	APL - Silver Spring, Maryland	TG-63-29	9/25/53
15	5/13-14/54	APL - Silver Spring, Maryland	TG-63-35	12/17/54
16	1/26-27/55	APL - Silver Spring, Maryland	TG-63-38	7/13/55
17	5/25-26/55	Esso Laboratories, Linden, N. J.	TG-63-40	11/1/55
18	11/9-10/55	Ordnance Aerophysics Lab., Daingerfield, Texas	TG-63-42	3/30/56
19	6/4-5/56	McDonnell Aircraft Corp., St. Louis, Mo.	TG-63-43	10/15/56
20	5/16-17/57	Bendix Corporation, Mishawaka, Indiana	TG-63-44	1/2/58
21	4/15-16/58	Marquardt Aircraft Co., Van Nuys, Calif.	TG-63-45	10/2/58
22	10/30-31/58	APL - Silver Spring, Maryland	TG-63-46	Undated
23	5/18-19/59	Experiment Incorporated, Richmond, Va.	TG-63-47	Undated
24	10/21-22/59	General Electric Co., Cincinnati, Ohio	TG-63-48	3/30/60
25	4/26-27/60	APL - Howard County, Maryland	TG-63-49	Undated
26	11/15-16/60	Ordnance Aerophysics Lab., Daingerfield, Texas	TG-63-50	Undated
27	5/4-5/61	Atlantic Research Corp., Alexandria, Va.	TG-63-51	Aug. 1961
28*	11/15-16/61	APL - Howard County, Maryland	TG-420-1	Jan. 1962
29	6/21-22/62	Bendix Corporation, Mishawaka, Indiana	TG-63-52	Sept. 1962
30*	3/19-20/63	APL - Howard County, Maryland	TG-420-2	May 1963
31	5/19-20/64	APL - Howard County, Maryland	TG-63-53	June 1964

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